Session 10

Organizing What We Know: The Structure of the Disciplines

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I. Key Questions and Learning Objectives

Key Questions

- How does the way knowledge is organized influence learning?
- How can teachers use the structure of a discipline to organize their teaching and enhance student learning?

Learning Objectives

- **Structure of the disciplines**—Teachers will understand that disciplines have structures representing interrelated core ideas and particular modes of inquiry. They will think about how to use these core ideas and inquiry tools to help students understand disciplinary ideas more deeply.
- **Pedagogical content knowledge**—Teachers will consider the kinds of knowledge of content and students they need in order to represent disciplinary ideas so that they are more likely to be understood.

II. Session Overview

> Grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully. To learn structure, in short, is to learn how things are related .... The teaching and learning of structure, rather than simply the mastery of facts and techniques, is at the center of the classic problem of transfer.
>
> —Jerome Bruner (1960, pp. 7 & 12)

There are two ways to think about the principles of learning. One is to ask, "What are the principles that are so general and universal that in some ways they apply regardless of what you are teaching and to whom?" There are such principles, and they can be very useful. We have been dealing with them throughout this course. But there are also questions about principles of learning that are particular to the domain under study and to the kinds of understanding that learners bring to the table. Expert teaching in a subject matter rests on an understanding of how particular students are likely to come to this knowledge—what can be done to bridge the distance between what students understand and what counts as expert knowledge in the field. This is the essence of "pedagogical content knowledge," which is the special expertise that teachers have about subject matter and how to teach it (Grossman, 1990; Shulman, 1987).

At the core of pedagogical content knowledge is a deep understanding of the *structure of the discipline*—how knowledge is organized and pursued in a particular subject area—connected to a deep understanding of the particular students being taught. This disciplinary structure can be reflected in the curriculum and in teachers' pedagogical strategies. The structure of a discipline affects two things: 1) how knowledge and ideas are related and interconnected, and 2) how inquiries are carried out.

Structure of the Disciplines

All subject areas have structures that reveal the ways their core ideas are connected with one another. If students' learning is to be meaningful, they must gain access to the code of patterns and regularities that organize individual fields and relationships across fields. To teach a subject without introducing students to the organization of its core ideas would be like trying to tell a friend how to navigate a supermarket without giving them any sense of the organization of a grocery store (Shulman, 2001). Your friend would not know that she could find the milk she is looking for in the dairy section or that there is an entire section for produce where she could find all of the fruits and vegetables on her list. Just as a person with no clues to organizational structure would feel lost in search of an item in a grocery store, so might she think that an academic subject she is studying is a long list of unconnected facts without clues to detect the core ideas and patterns that surface repeatedly. Making these connections clear to students provides a window into the field and makes it possible for them to acquire meanings that would be hard to acquire otherwise.

Each discipline has a different structure. Subject matters differ not only in terms of their core ideas, but also in terms of how inquiries are carried out. Scientists, mathematicians, and historians go about posing and answering questions, building understandings, and drawing conclusions in different ways. The structures of the disciplines are the building blocks for organizing the curriculum to engage students in activities and experiences around these core ideas. These structures also pave the way for transfer to other ideas, subjects, and real-life problems inside and outside of school.

Organization of Core Ideas

Joseph Schwab (1978), a philosopher of science, explained the notion of the "structure" of a discipline by focusing first on the way the core ideas of a discipline are organized: What are the building blocks that reflect the central concepts in a discipline, and how do they connect with one another? (Schwab, 1978; Shulman, 2001). Schwab argued that teachers need to understand the structure of a discipline to help students acquire new knowledge and skills. For instance, mathematics is structured around core ideas like the inverse operations of addition and subtraction, the concepts of ratio and proportion, and the ideas of balance and equilibrium, among other topics. Whether students are engaged in primary arithmetic or algebra, these ideas repeat themselves again and again, and they organize much of the work people do in the field.

II. Session Overview, cont'd.

Researcher Liping Ma (1999) discovered that elementary arithmetic teachers organize their knowledge of the discipline into what she calls "knowledge packages," or clusters of ideas that are made up of interrelated concepts. These knowledge packages are also connected to each another, forming larger webs of ideas. Ma's research revealed that teachers' "knowledge packages" represent three kinds of mathematical knowledge: "procedural topics" (e.g., how to divide by a fraction); "conceptual topics" (e.g., the concept of fraction); and "basic principles" (e.g., a deeper understanding of the inverse operations of multiplication and division and their application to the whole subject area of mathematics.)

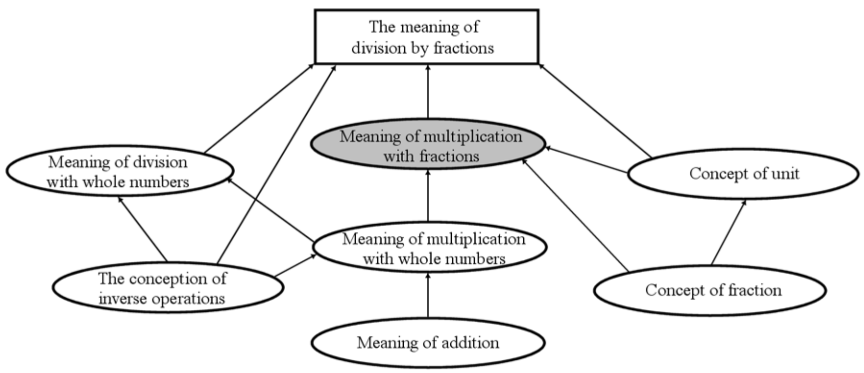

Figure 6. The 'knowledge package' for understanding the meaning of divisions by fractions

Ma found that "teachers with conceptual understanding and teachers with only procedural understanding . . . had differently organized knowledge packages" (1999, p. 22). Ma discovered that in China the teachers and students understand those packages and teach them as clusters of knowledge, whereas in the United States, arithmetic tends to be taught as a set of computational processes. She suggests that Chinese students outperform American students in international comparisons because Chinese teachers take the time to identify and focus on these core mathematical ideas in depth. This focus on a few large ideas and the ways they permeate many operations certainly reflects the curriculum organization in many countries where students perform well in mathematics. For example, in the first year of middle grades education in Japan, the curriculum framework instructs teachers to focus on only a few major concepts for the year. These include ideas like "deepening the understanding of integer," ratio and proportion, and estimation.

Jerome Bruner (1960) approaches the structure of the disciplines by considering the psychology of learning and development, memory, and transfer. Bruner's work in cognitive development and in early language acquisition shaped how he considers the structural aspects of the disciplines. Bruner describes how students' interest and enjoyment of learning can be heightened through the "sense of excitement of discovery" they experience as the structure of a discipline becomes clear to them. It can be exciting for students to become aware of patterns and regularities in the subject and how certain ideas keep coming up again and again to be applied in new ways.

So, for example, as students learn that 2 plus 3 is exactly the same as 3 plus 2 and that 2 times 3 is exactly the same as 3 times 2, they can become excited about the wonderful structure called commutativity. And when the teacher then asks, "Well, does that mean that 3 minus 2 is the same as 2 minus 3, or that 3 divided by 2 is the same as 2 divided by 3?" and they begin to realize that is not the case, they gain access to one of the structures of mathematics—that some operations have this commutative property and others do not, and what the implications are. This becomes an aid to transfer, because as students begin to get access to those structures, they are getting ideas that they can apply again and again in new situations. Many scientists will argue that in modern biology the theory of evolution is the central structure of all biology. It includes core concepts like adaptation, organisms, and environments that undergird ideas about the role of chance in how well organisms adapt to environments and how that relates to notions of evolution.

II. Session Overview, cont'd.

Understanding the organization of a subject area can make learning more comprehensible and transferable to new situations. Bruner explains:

> This type of transfer is at the heart of the educational process—the continual broadening and deepening of knowledge in terms of basic ideas .... The more fundamental or basic is the idea he has learned, almost by definition, the greater will be its breadth of applicability to new problems (Bruner, 1960, pp. 17-18).

Both Bruner (1960) and Schwab (1962) assert that students can understand the basic concepts of subject matter at an early age when they are taught in an intellectually honest way: "We begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development" (Bruner, 1960, p. 32). In fact, Bruner suggests that students be taught in a *spiral curriculum* that introduces central concepts in the disciplines early in a child's education and revisits these concepts again and again in the later grades in more sophisticated ways. "By consistently reexamining material taught in elementary and secondary schools for its fundamental character, one is able to narrow the gap between 'advanced' knowledge and 'elementary' knowledge" (Bruner, 1960, p. 26).

For example, in the video for Session 2 of this course, Development and Learning, elementary, middle, and high school students are all pursuing the central physics question, "How do mass and velocity affect momentum?" Each age group represents the subject matter knowledge differently, representing, in turn, the three ways of representing subject matter—active, graphic, and symbolic—that Bruner describes (Bruner, 1966, pp. 44-45). Fe MacLean's first-grade students use manipulatives like incline ramps, blocks, and balls to *actively represent* the concept of velocity and to answer the question, "Can something light and something heavy reach the bottom of a hill at the same time?" George Mixon's eighth-grade students chart data to *graphically represent* the formula "momentum = mass x velocity" and to develop and test their hypotheses. Ken Gilliam's 12th-grade students *symbolically represent* the physical law of the conservation of momentum as they measure a vehicle's impact on different barriers. At each level of schooling, students are grappling with similar, important content, through engaging activities, in an "intellectually honest" way and in a manner appropriate to their developmental levels. Gaining a deep understanding of these physics concepts and the ways to represent them prepares the students well for transferring this knowledge to a variety of situations.

Understanding the structure of a domain helps people learn things more efficiently. For example, teaching vocabulary based on how the language is organized helps students understand that the structure of language is not random and enables them to learn rules for broader application. When students learn vocabulary based on the root meaning of words (for example, that "photo" means light), they can transfer this knowledge to words such as photosynthesis and photographic and many others that they will encounter in the future. When students understand the meaning of various prefixes and suffixes (for example, "pre" and "ante" mean before or in front of), they can transfer their meaning to words such as precursor, antecedent, and antebellum. Students make connections when teachers can provide students with access to these core structures of a subject matter, as opposed to learning a haphazard list of words.

Similarly, in a discipline like foreign language, if a student tried to learn how to conjugate every verb in the language, one at a time, as if each verb had a unique character, the student would spend a lifetime learning the language. Every time the student encountered a new verb, he would think he had to learn its conjugation from scratch rather than understanding the organization of conjugations. Knowing the structure of verb conjugations enables transfer. For instance, if a student asked, "What's the word for 'to bungee jump'?" upon hearing its translation in another language he might think, "That is a form of the standard action verbs 'to walk' or 'to jump.'" He could then figure out conjugations for "I bungee jumped yesterday," or "I will bungee jump tomorrow." He would know how to conjugate a new verb because he understands a core principle that applies repeatedly (Shulman, 2001). These consistent patterns apply in other fields, such as music. For example, certain kinds of musical performances have structures that listeners learn to anticipate, e.g., the fast-slow-fast tempos of a three-movement symphony, or the alternating conversational and percussive rhythms of rap music.

II. Session Overview, cont'd.

The structure of the disciplines is different within each subject area. In the study of literature, for example, teachers ask students to consider the core ideas of theme, character, and plot: "What is the theme of this story? What are the qualities of these characters? What is the plot, and how is plot similar to or different from the theme?" When you are studying Shakespeare, key understandings include the difference between the structure of a tragedy and the structure of a comedy. Bruner illustrates how wrestling with these core ideas can lead to deeper understanding:

> The high school student reading *Moby Dick* can only understand more deeply if he can be led to understand that Melville's novel is, among other things, a study of the theme of evil and the plight of those pursuing this 'killing whale.' And if the student is led further to understand that there are a relatively limited number of human plights about which novels are written, he understands literature the better for it (Bruner, 1960, p. 24).

In a discipline like history, students may consider core ideas about human power, the clash of cultures, and how societies organize themselves to engage in government, commerce, or religious pursuits. Teachers can help students learn that, if they understand these concepts, they can look at different societies and different nations over time and be able to see patterns and discontinuities, propositions, generalizations, and connections.

Teachers can help students understand the structure of a topic by providing an overarching conceptualization of the big ideas and then locating specific facts or information that relate to the big ideas. For example, in the video from Session 3 of this course, Fe MacLean asks her first-grade students to group animals by categories of mammals, birds, reptiles, and fish. She then asks her students to identify how animals move—fish have tails, birds have wings, some animals have feet—and to relate the ways in which animals move to their larger classification. She is helping her students think like a biologist would. [See Session 3, Cognitive Processing.] Teachers can also help students develop a schema or concept map for how ideas fit together. A teacher might develop a concept map that details the characteristics of mammals and links them to examples to help her students understand how various animals share certain features. As students think through these relationships, they are not only learning facts, they are beginning to examine the world in the ways that scientists do, since classification around properties is one of the modes of inquiry that is central to science.

Central Modes of Inquiry

Schwab also considered *the central modes of inquiry* and knowledge-finding tools of the disciplines: How does each discipline construct, critique, and revise knowledge? How do you know something is true? What counts as evidence? (Schwab, 1978). Each discipline and subject matter has a different manner of posing questions and solving problems. The structure of a discipline also determines what kinds of inquiry skills are important and how they should be learned and applied. For instance, students need to learn how to estimate in mathematics, to make predictions in science, to plan their writing, and to recognize specific story structures while reading (Gage & Berliner, 1998). As we discussed in Session 3, Cognitive Processing, expert historians, mathematicians, and scientists recognize familiar patterns as they are solving problems, which helps them navigate new territory more efficiently. They are also aware of which ideas are central and which are peripheral to the problems they face.

Each discipline also has a different conception of what constitutes evidence or "proof." As John Bransford and his colleagues explain, "the evidence needed to support a set of historical claims is different from the evidence needed to prove a mathematical conjecture, and both of these differ from the evidence needed to test a scientific theory" (Bransford, Brown, & Cocking, 2000, p. 143). Certain ideas do cut across disciplines—notions of description, analysis, careful observation, the evidence for a claim, and theory. But the fundamental process of experimentation, which is at the heart of work in science, has no real analogy in history, for example. One cannot design an experiment in which we put one historical period in an experimental group and another one in a control group and see what the difference is. Nonetheless, students of history can still make comparisons and try to create evidence. A historian has to look for comparisons where nature, not scientists, has made experiments. Evidence is still generated through comparison and contrast, careful observation, and analysis. Issues of the perspective that inform historical accounts take on importance alongside issues of verification.

In Avram Barlowe's 12th-grade history class, for example, students grapple with the principle of democracy when they consider the question, "Who should govern people and why?" [See this session's video.] As they investigate the rights of African American citizens after the Civil War, they first consider and evaluate the source of historical information they are using as evidence. Is it verifiable information? Is it a value or an opinion statement? What is the vantage point of the person or group holding that viewpoint? Second, students examine the "truth" of the evidence they are analyzing by asking, "Did it really happen that way? What is the evidence that it really happened that way?" Third, students connect to this historical issue with their own perspectives and explore their sense of American democratic society then and now. This blend of contexts, historical and contemporary, gives meaning to their inquiry.

This exemplifies what Schwab meant when he suggested that students need to learn how experts in a discipline think, how they build new knowledge, and how they interpret meaning from the structure of a discipline. He adds that when teachers understand the structure of a discipline they can help students examine ideas critically, analyze the "kind" of information gathered, examine the "truth" of statements, and interpret the "meaning" of information (Schwab, 1978).

Structure and Curriculum

The structure of the disciplines—ways of organizing key ideas and differing ways of posing and answering questions—should inform the overall curriculum. Making decisions about what ought to be taught involves asking, "What are the properties of an activity, task, or project that will lead to the greatest teaching and learning?" and "What is the organization of ideas that would make it most coherent, understandable, learnable, and transferable by a student? How does one match the activity with students' interests and abilities?" (Shulman, 2001).

If teachers' decisions about instruction are informed by an understanding of the underlying principles of their subject, they can build a bridge between the material and their students. As Bruner explains:

> The problem is twofold: first, how to have the basic subjects rewritten and their teaching materials revamped in such a way that the pervading and powerful ideas and attitudes relating to them are given a central role; second, how to match the levels of these materials to the capacities of students of different abilities at different grades in school (Bruner, 1960, p. 18).

One of the issues teachers constantly struggle with is how to organize learning so that it can be understood and remembered. Part of the answer to this question is found in how teachers choose *general ideas* to guide the content of teaching and how teachers engage students in *activities and experiences* around these ideas, with the goal of students gaining "a sense of intelligent mastery over the material" (Bruner, 1960, p. 30). Choosing the big ideas to focus on requires figuring out what principles and concepts are key to a given subject and how curriculum decisions might be made with these in mind. Shulman (2001) asks, for instance, "If you were an English teacher, and you could only teach one story, one novel, or one piece of literature that had to represent, in some fashion, the window to the world of literature for your students, which would you choose? Would it be *King Lear?* Would it be *Romeo and Juliet?* Would it be one of Arthur Miller's plays? Would it be a Faulkner short story? Would it be Tolstoy's *War and Peace?* And why? And what would you ask students to do with the piece of literature?" This question could be applied to all subject areas as teachers wrestle with the big ideas in their discipline.

In some cases, national content standards, such as those issued by the National Council of Teachers of Mathematics and the National Council of Teachers of English, can help identify the core ideas and understandings of a discipline. Most states have also adopted standards for student learning, along with curriculum frameworks that explicate how these understandings can be taught. Although some curriculum frameworks are indiscriminate in listing hundreds of ideas to be learned, irrespective of their utility for gaining a sense of the overall field, most provide useful guidance for focusing in on the core skills and knowledge that are worth organizing a curriculum around. Teachers can work from these guidelines to represent the ideas of a subject, to relate new learning to their students' prior experiences, and to design learning activities related to the core concepts of the disciplines. [See the Web sites of the national subject matter councils in Section VI below.]

II. Session Overview, cont'd.

Pedagogical Content Knowledge

While developing curriculum based on the structure of a discipline goes a long way toward supporting learning, it is not enough to ensure that what is taught will be understood. Effective teaching involves knowing not only what to teach, but also how and when to teach important content to the particular students in a given classroom. This knowledge includes understanding how to capitalize on the prior knowledge or experiences the students bring to the classroom to create meaningful connections between what the students already know and what teachers want to help them know. For example, a challenge in teaching mathematics is how to teach an abstract subject to young children who are very much caught up in their own personal, concrete experiences. Doing so requires "pedagogical content knowledge"—an understanding of what kinds of experiences, what kinds of objects, and what kind of examples can be used to help students acquire an understanding of complex ideas.

Pedagogical content knowledge "represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (Shulman, 1987, p. 8). Considering how to represent ideas is a critical aspect of this kind of knowledge. Shulman asks:

> How do you *represent the ideas of a subject* and the ways they are connected with one another so that students do not fall into one of the three pathologies of learning: amnesia, fantasia, and inertia? *Amnesia* is forgetting. It occurs when information has not been learned in memorable, usable ways. *Fantasia* occurs when students end up with a misconception or a set of misconceptions about the ideas taught; they have a distorted grasp of a concept. *Inertia* is the absence of transfer, where students understand the ideas, but cannot apply them outside of the immediate context in which they learned them (Shulman, 2001).

Pedagogical content knowledge is shaped not only by how teachers think about *why* they are teaching their subject, but also by their understanding of *what* they are teaching, *how* they are creating curriculum, and *when* students are ready for learning. Pedagogical content knowledge involves knowing *how to organize curriculum* to make important ideas understandable to students at different levels of development and with differing prior experiences; it thus requires a deep understanding of the subject matter as well as a strong understanding of the student's intellect, motivation, development, and culture. The notion of pedagogical content knowledge grew out of the following questions: How is it possible for someone who already knows something to teach it to someone who does not? How do you create a bridge between what you know and what somebody else does not yet know, but needs to know? Answering these questions requires understanding both what you know and what is already inside your students' heads so that you can create powerful and rich connections between the two. It involves understanding a subject well enough to be able to identify and put into practice the variety of "hooks" that can help students understand new material; it also involves having a profound understanding of students so teachers understand where the "hooks" are in their experience as well.

Teachers need to adapt their pedagogy to the specific material they are presenting within a discipline. For example, in the field of medicine, one might ask, "How do you diagnose a disease?" An initial response might be, "First, you take a history, then you do a physical exam, then you do lab tests, and then you interpret them." And that is all true. But, then the question is, "How would you make a differentiated diagnosis between abdominal pain as caused by diabetes and abdominal pain as cause by a ruptured spleen?" At that point the response, "First you start with a history, then you go to a physical, and then you take lab tests" while true, is fairly useless. At that point, you need to ask, "How does somebody with a ruptured spleen present and how is that different from someone with an acute onset of adult diabetes, both of which share the abdominal pain symptom, among others?" "What would I be asking someone in a history? What would I be doing specifically in a physical diagnosis? What lab tests would I take and how would I interpret all of the information gathered in order to make a differential diagnosis?" These latter questions are aimed at a very different level of understanding and are representative of "clinical" content knowledge (Shulman, 2001).

II. Session Overview, cont'd.

Similarly, in education, there is a difference between asking, "How does someone learn?" and "What is involved in someone learning Shakespeare's *The Tempest?"* Considering what is involved in a student learning about this specific piece of literature involves more than a consideration of general principles of learning. Teachers need to anticipate what it is about the literature that makes it subtle, that makes the material easy or difficult for students to understand. Teachers also need to design the pedagogy so that it focuses on the specific knowledge and skills they want to have students learn. Often imagining the end result leads to, "What would learning look like in this particular case if it were to occur? What does somebody look like who understands *The Tempest?* What does understanding *The Tempest* even mean?" (Shulman, 2001).

The goal of teaching is not only to encourage particular understandings, but also to develop dispositions, values, commitments, and attitudes particular to a content area. For example, a good journalism teacher teaches her students to make tough decisions, to look for both sides of a story, to be critical and self-critical, and to be ethical (Austin, 2000). Journalism students learn a whole set of dispositions and values at the same time that they learn specific literacy skills. The teacher's job is to coach her students to become critical consumers of the media and to be aware of the responsibilities of being a reporter by modeling this practice herself and by providing clear feedback on their work.

Another aspect of pedagogical content knowledge is the differing instructional strategies teachers use—metaphors, analogies, stories, visual representations, etc.—to represent content knowledge. Each of these methods will be variously effective with different students. Howard Gardner (1999) explains that for teachers to reach "the infinite variety of students," analogies are a good pedagogical tool to introduce unfamiliar concepts with experiences that are more familiar to students. Gardner offers one analogy to describe Mozart's work, "His productivity . . . was very steady: like a bird carefully building each new nest or a squirrel burying each new nut, he proceeded from one composition to another in workmanlike fashion" (Gardner, 1999, p. 200). He offers the contrasting analogy of a "meteor" to describe Mozart's turbulent personal life. These analogies are helpful to a learner who has an idea about the characteristics of a meteor or of the particular animals used. The analogies chosen must be understandable to the particular students being taught.

Researcher and teacher Deborah Ball provides a useful example of using carefully chosen representations and reasoning processes to foster expert inquiry skills. She helps her elementary students engage in the work of mathematicians—to "conjecture, experiment, build arguments, and frame and solve problems" (Bransford et al., 2000, p. 166). Using these modes of inquiry, which take students beyond mere computation, Ball engages her students with concrete manipulatives, graphic examples related to real-life problems, and practice in identifying mathematical patterns. For instance, to illustrate the concept of negative numbers, she asks her students to hypothetically ride an elevator in a building that has floors above ground and underground, or "below zero." Ball asks her students to observe, "How many ways are there for a person to get to the second floor?" (Bransford et al., 2000, p. 168). The concrete representation of an elevator—something her students are familiar with—helps to frame her students' inquiry into the properties of positive and negative integers. Furthermore, using the notions of evidence that are central to mathematical inquiry, Ball places the responsibility on her students to verify their solutions to the problem.

One of the misconceptions about pedagogical content knowledge is that it is a memorized set of analogies, diagrams, or tricks for each of the main concepts. For certain key concepts that are always hard for students to learn, teachers need to discover, use, and think of multiple ways of approaching those concepts. This is not the same as creating a prescriptive set of activities. Rather, this approach requires ascertaining what the students already understand, or misunderstand, and applying a set of strategies to build bridges between students and the content. Considering issues of disciplinary structure and pedagogical content knowledge raises the following questions for teachers: As you plan curriculum, what do you identify as the important, generative ideas in your discipline? As you plan inquiries, what are the central tools and habits of mind students need to develop? And as you plan instruction, how do you develop hooks into the content for your students?

III. Additional Session Readings

Bransford, J. D., Brown, & A. L., Cocking, R. R. (Eds.). (2000). Effective teaching: examples in history, mathematics, and science (Chapter 7). In *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press. [Online]. Available: http://books.nap.edu/html/howpeople1.

Gardner, H., & Boix-Mansilla, V. (1994, February). Teaching for understanding within and across the disciplines. *Educational Leadership,* 51 (5), 14-18. [Online]. Available: http://www.ascd.org/readingroom/edlead/9402/gardner.html.

IV. Session Activities

Getting Started

To the Facilitator: These activities can be used as session warm-ups or as activities that occur after video viewing.

Answer the following questions in a free-write, pair-share, or small-group discussion.

In your teaching context, think of a time when you had a misconception about your subject matter, or a misunderstanding about how the building blocks of your discipline connect to each other. Now think of a time when your students also had a misunderstanding or incorrect, preconceived idea of the subject matter.

- How did you change your thinking about your misconception?
- How could you assist your students to change their misconceptions about the ideas you are teaching?

Discussion of Session Readings

To the Facilitator: You may want to select questions from the Other Learning Activities and Assessments section to launch a discussion of the session readings. The questions used for the Checking for Understanding activities may be a particularly helpful resource.

Session Video

Every discipline has a set of big ideas that are connected to each other and provide the glue that holds the subject area together. Each discipline also uses particular methods of study that reflect how knowledge is built in that field. For example, scientists conduct experiments and historians evaluate historical evidence from different perspectives. To really master a discipline, students need to understand what the big ideas are and how they are connected. If they learn to think like experts in that field, their learning will be much more efficient. This video illustrates how teachers represent subject matter knowledge so that students can better understand the structure of the disciplines they are studying. The teachers in the video help their students think and act the way experts in a given field think and act—to bridge the gap between what students learn in class and what counts as expert knowledge and understanding.

IV. Session Activities, cont'd.

Background on Teachers

Julie Helber teaches fourth-grade math and science at Paddock Elementary School in Milan, Michigan. Ms. Helber is a National Board-certified teacher and recipient of the National Educator Award from the Milken Family Foundation. She received her master's degree from Eastern Michigan University in curriculum development, and her bachelor's degree in kinesiology from the University of Michigan.

In the first segment, Ms. Helber helps her students learn to think and act like scientists and mathematicians as they learn about static electricity and, later, about calculating area. She guides them through inquiries that are structured to represent the modes of inquiry experts follow in those fields as they collect data. Ms. Helber challenges her students to clarify their thought processes by encouraging them to explain their answers and reason about their findings.

Mary Edmunds teaches 10th- through 12th-grade biology and physics at the Detroit High School for the Fine and Performing Arts in Detroit, Michigan. A 14-year veteran of teaching, Ms. Edmunds is a National Board-certified teacher and has been a National Board coach and mentor for seven years. She received three Golden Apple Awards and is a presenter on entomology for the Metro-Detroit Science Teachers Association (MDSTA). She received bachelor's and master's degrees in science from the University of Michigan, and a specialist degree in science education from Wayne State University.

In the second segment, Ms. Edmunds helps her students understand cell biology by first connecting the issues of disease to the drama of the science fiction novel, Andromeda Strain. She then engages them in the scientific method so they can examine the features of cell membranes for themselves. Edmunds helps her students experience the power and the limitations of laboratory science. She works with her students' prior knowledge and their misconceptions to further their understanding of science.

Avram Barlowe teaches 10th- through 12th-grade American history at Urban Academy High School in Manhattan, New York City. He has 22 years of teaching experience and is a National Board-certified teacher. Mr. Barlowe holds a bachelor's degree in history from the City College of New York, and a master's degree in liberal studies from the City University of New York.

In the third segment, Avram Barlowe engages his students in reading primary source materials so that they can explore the events and opinions of post-Civil War Southerners and understand the perspectives that shaped historical decisions. In exploring legislation of the time, he focuses on central ideas like governance and human rights and he raises essential questions like: Who should govern? And why? He engages his students in historical research, the examination of evidence, and the development of argument to teach key historical concepts and modes of inquiry.

IV. Session Activities, cont'd.

Discussion of Session Video

To the Facilitator: You may want to pause the tape at the following points to discuss these questions. If you are watching a real-time broadcast on the Annenberg/CPB Channel, you may want to consider the questions as you watch and discuss some of them afterward.

1. Students Think Like Scientists and Mathematicians (Julie Helber)

Video Cue: *The Learning Classroom* icon fades out at approximately 10:45 into the program.

Audio Cue: Ms. Helber says, "... And so by hearing how somebody else is thinking, and it goes back to me modeling how I'm thinking about things, and to maybe change their way of thinking or to expand the way that they think."

- What teaching strategies did you notice Ms. Helber using to encourage her students to think like scientists and mathematicians?
- What does it mean to think scientifically and mathematically?
- How Ms. Helber help her students learn to act and behave as scientists and mathematicians?

2. Students' Hands-on Investigation (Mary Edmunds)

Video Cue: *The Learning Classroom* icon fades out at approximately 18:00 into the program.

Audio Cue: Ms. Edmunds says, "It weighed more. There you go! It weigh- ...." Boy says, "So it blew up like a balloon ... oh!" Ms. Edmunds says, "You got it!"

- What inquiry skills, perspectives, and understandings are these students developing that are specific to biology?
- What strategies did you notice Ms. Edmunds using to help her students learn to think like scientists?

3. Use of Evidence and Argument (Avram Barlowe)

Video Cue: *The Learning Classroom* icon fades out at approximately 25:30 into the program.

Audio Cue: Mr. Barlowe says, "They're looking at the question of the freed men after the war in the context of the Emancipation Proclamation, Lincoln's role, the slaves' self-emancipation. They're building on what they already know so there is an intellectual growth, I think, that you can see."

- In this classroom, how is Mr. Barlowe helping students learn to develop a sense of historical evidence and historical perspective?
- What counts as persuasive evidence in a historical argument?
- What counts as persuasive evidence in your own subject area?

V. Other Learning Activities and Assessments

> **To the Facilitator:** These activities and assessments are for you to choose from according to your group's needs and interests. Many of the activities offered here would work equally well as assignments both inside and outside of class. You may want to use class time to prepare for and/or reflect on any activities assigned as homework.

Applications

1. Journal

Identify the central ideas in your subject area.

Imagine that you have eight weeks to teach your class a unit in your favorite subject area. Think about what you plan to teach in those eight weeks. (If you want, you can jot down a few ideas about what you would want to cover.) Now imagine you learned that you have to teach this unit in only four weeks.

> **To the Facilitator:** Pose each of these questions to the learners and allow them to consider them for a time before going on to the next one.

- What content would you keep in and what would you leave out?
  - For example, would you cut out the last four weeks of your unit, or would you try to reorganize it in some fashion to make sure that certain ideas or stories or principles or concepts or facts were in it?
- What would you do if you learned that you only have two weeks to teach this unit?

> **To the Facilitator:** This can be conducted as a paired conversation between two teachers, preferably in the same field. Alternatively, learners can do free-writes answering these questions. They can exchange their journals with a partner, then respond in writing to the other's journal, making comments and asking questions. The original writer then receives his or her journal back with responses from the partner. This can continue, but the original writers should contribute the final word on their own journal responses.

Now imagine that you have one day to teach the essence of this entire unit in your discipline. In this one day you need to somehow help students get access to what really counts in this unit of study.

- How has your thinking changed to rethink and rethink and rethink what it means to understand this subject well?
- What's the 'big idea' here?
- Why do you think this idea is a particularly important one for understanding this domain?" (Shulman, 2001).

V. Other Learning Activities and Assessments, cont'd.

2. Field Assignments

a. *Connect core ideas with pedagogies in your subject area.* Identify one concept that you are teaching your students in your subject area. Identify the big ideas of this particular topic.

   Create a concept map of the core ideas that shows how the building blocks of your topic fit together. Think about how you might teach your students this topic.

   - How will you capitalize on your students' experiences and prior knowledge of this concept?
   - How might you consider your students' interests and abilities related to this topic?
   - How might you help your students form connections of the major ideas and the relationships among them?
     - For instance, what analogies, metaphors, stories, or visual representations could you use?

b. *Scaffold students' inquiry learning.* Organize a task or activity for your students in which they explicitly learn about and apply the tools of inquiry in the discipline (e.g., conducting investigations or evaluating evidence using the scientific method; uncovering explanations of events using the primary sources and tools of historical inquiry; using strategies of literary critique, text-based analysis in relation to themes; developing writing processes used by authors; engaging in mathematical argumentation and proof).

   Think about the steps you want to take to scaffold students' learning from this inquiry activity:

   - What do I want my students to be able to do?
   - What does it look like to be competent in this task?
   - What are some of the processes skilled thinkers use when they apply the tools of inquiry in the discipline?
   - What tools can I provide my students to scaffold their inquiries?
   - How can I demonstrate how an expert might conduct such an inquiry?
   - What student performances might prompt me to step back and offer students more independence in their learning?

Checking for Understanding

1. Short-Answer Question

As teachers you want to organize learning so that it is understood. In your field, give a common example of each of the three "pathologies of learning: amnesia, fantasia, and inertia" that often prevent students from using what they have learned.

2. Essay Question

Write a short essay on two of the content-specific pedagogies that you use in your discipline.

- What content pedagogical strategies do you use to teach core concepts or modes of inquiry in your subject matter?
- What challenges do you encounter in choosing these specific pedagogies?
- What strategies work well? Why?

V. Other Learning Activities and Assessments, cont'd.

3. Reflective Essay

Write on the following: Curriculum should be organized around the core knowledge and modes of inquiry of a discipline. Thinking about an area in which you teach, identify what you see as the most important modes of inquiry and discuss (1) why it is important for students to learn these skills, and (2) what kind of curriculum tasks are essential to enable them to engage in this kind of learning?

Long-Term Assignments

Curriculum Case Study

Consider your case study learning problem from a pedagogical content perspective. (Note: If your curriculum case is on a unit you plan to teach in the future, answer in the form of what you project for that unit. You may have to anticipate some of your students' reactions.)

- How did your representation of the structure of the subject matter influence what happened in this case?
- What different approaches could you take to reach students with different levels of understanding of the material?
- What pedagogical strategies can you use to make the subject material meaningful and accessible to your students?

To the Facilitator: You will find other learning activities on the course Web site at www.learner.org/channel/courses/learningclassroom. You will want to look ahead to assign learners the reading and any homework for the next session.

VI. Web Sites and Organizations

The National Board for Professional Teaching Standards: http://www.nbpts.org/

This Web site, which describes the history and background of the National Board for Professional Teaching Standards, includes the standards for certification in various subject areas and provides suggestions for using the National Board process as a platform for reform.

National Council of Teachers of Mathematics (NCTM): http://www.nctm.org/

This Web site includes resources, lessons, and activities for teaching mathematics in elementary, middle, and high school. NCTM principles and standards for teaching K-12 mathematics are listed on this site.

National Science Teachers Association (NSTA): http://www.nsta.org/

This Web site highlights teacher resources, national satellite broadcasts, and regional events for K-12 and college science education. Science Class, a monthly electronic newsletter, is available to nonmembers. NSTA membership provides support with standards, assessment, inquiry-based learning, and integrating technology and teaching.

National Council for the Social Studies (NCSS): http://www.ncss.org/

This Web site includes information for social studies educators, including teaching resources, information about professional development, and the national social studies standards.

National Council of Teachers of English (NCTE): http://www.ncte.org/

This Web site includes resources for K-12 and college teachers in English studies, literacy, and language arts. The site includes a collection of standards-based lesson plans and Web resources, an index of subject-specific resources, funding resources, and information on national conferences.

American Council on the Teaching of Foreign Languages (ACTFL): http://www.actfl.org/

This Web site includes online resources, publications, workshops, and proficiency testing information for foreign language educators at all levels of instruction.

VII. References and Recommended Readings

Note that the recommended readings are marked with an asterisk (*).

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